Intramuscular Rotator Cuff Cysts: Association with Tendon Tears on MRI and Arthroscopy

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OBJECTIVE. This study was designed to explore the relationship between intramuscular cysts and rotator cuff tendon tears.

CONCLUSION. Intramuscular cysts are strongly associated with rotator cuff tendon tears. Identification of such a cyst should prompt a search for a rotator cuff tear. Findings on MR arthrography and surgery suggest that a delaminating component of the rotator cuff tear may lead to the development of these cysts and may explain the occasional discrepancy between location of tears and location of cysts.

MRI of the shoulder has proven to be an accurate noninvasive examination for the evaluation of patients with shoulder pain. Two main types of periarticular cysts are frequently seen on shoulder MRI, both of which have a strong association with underlying abnormalities. The most common is the paralabral cyst that results from a glenoid labral tear [1]. Although many of these cysts are asymptomatic, strategically located cysts may result in compressive neuropathies that can mimic rotator cuff tears [2]. Acromioclavicular juxtaarticular cysts have been described in association with full-thickness rotator cuff tears and a degenerated acromioclavicular joint [3, 4]. These cysts often present as a supraclavicular mass.

A third but relatively unknown type of periarticular cyst may be seen on MRI of the rotator cuff. This intramuscular cyst or intramuscular ganglion typically is located within the sheath or substance of one or more muscles of the rotator cuff and typically is not palpable or visible at arthroscopy. It has been proposed that these cysts are analogous to paralabral cysts in that an associated rotator cuff tear allows fluid from the glenohumeral joint to leak out into the periarticular tissues [5]. The purpose of this study was to explore the relationship between the presence and location of intramuscular cysts of the rotator cuff and the type and location of rotator cuff tears.

Materials and Methods

The reports from all (conventional and arthrographic) shoulder MRI examinations performed from 1996 to 2003 were searched using the Folio database (Open Market, Inc.) for the words intramuscular, synovial, cyst, or ganglion. The total number of reports searched was 9,366. The only selection criterion was the description of an intramuscular cyst or ganglion. Patients who had prior shoulder surgery and patients with paralabral or acromioclavicular joint cysts were excluded. Institutional review board approval was obtained.

All MRI was performed at 1.5 T (Twinspeed, GE Healthcare; or Sonata, or Siemens Medical Solutions) with a dedicated shoulder coil. Routine MRI consisted of sagittal oblique T1-weighted (TR/TE range, 450/8–10; 4 mm thick; skip, 0 mm; matrix, 512 × 192), inversion recovery (TR/TE, 5,000/48; TI, 150 msec; 4 mm thick; skip, 1 mm; matrix, 256 × 192), coronal oblique proton density–weighted (2,500/20; 3 mm thick; skip, 0.8 mm; matrix, 512 × 192), T2-weighted (3,800/100; 3 mm thick; skip, 0.8 mm; matrix, 256 × 192), fat-suppressed T2-weighted (2,700/50; 3 mm thick; skip, 0.8 mm; matrix, 320 × 256; zero-fill interpolation function, 512), and axial gradient-recalled echo images (550/15; 20° flip angle; 3 mm thick; skip, 1 mm; matrix, 256 × 192). MR arthrography after intraarticular administration of dilute gadolinium consisted of sagittal oblique and coronal oblique T1-weighted (TR range/TE range, 400–600/8–10; 3 mm thick; skip, 0–1 mm; matrix, 256 × 192), axial and coronal oblique fat-suppressed T1-weighted (425–450/8–10; 3 mm thick; skip, 0–1 mm; matrix, 256 × 192), and coronal oblique T2-weighted images (3,700/100; 3 mm thick; skip, 0.3 mm; matrix, 256 × 192). Fat suppressed T1-weighted images (400–600/8–10; 3 mm thick; skip, 0–1 mm; matrix, 256 × 192) with the arm in

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the abducted and externally rotated (ABER) position were occasionally obtained. IV gadolinium was not administered in any case.

All studies were independently reviewed on a clinical workstation by two musculoskeletal radiologists. Neither reviewer was aware of the original interpretation or surgical correlation. One reviewer was aware of the nature of the study (correlation of cysts with rotator cuff tears) at the time of analysis. The second reviewer assessed only the presence, location, and type of tendon tear. Disagreements were settled by consensus.

The following were collected from the database: age, sex, and laterality of examination. The following were determined retrospectively by two musculoskeletal radiologists: presence and location of intramuscular cysts and presence, location, and type of rotator cuff tendon tear. The radiologist aware of the nature of the study also measured the size of the cysts in their longest dimension. The rotator cuff tears were classified as full-thickness, partial-thickness articular surface, partial-thickness intrasubstance, or partial-thickness bursal surface. Imaging findings were then correlated with surgical findings.

MRI criteria for an intramuscular cyst were a rounded, elliptic, or fusiform fluid collection that was contained within the fascial investiture (sheath or substance) of one of the muscles of the rotator cuff and that followed fluid signal intensity on all pulse sequences. Rotator cuff tendon tears were defined as areas of tendon discontinuity that showed increased signal intensity on proton density–weighted images and remained of high signal intensity on T2-weighted sequences. Full-thickness tears were defined as tears that extended from the articular surface to the bursal surface of a given tendon. Partial-thickness tears were defined as tears that involved some but not all of the thickness of a tendon and were classified according to which component was involved: articular surface, intrasubstance, or bursal surface.

Results

The database search resulted in 9,366 shoulder MRI examinations. After exclusion of patients who had undergone prior surgery or whose reports described paralabral or acromioclavicular joint cysts instead of intramuscular cysts or ganglia, the study group consisted of 32 patients. The demographics of these patients and the type of MRI performed are shown in Table 1.

Of the 32 patients, 14 had cysts in the supraspinatus, 11 in the infraspinatus, five in the subscapularis, and two in the teres minor (Fig. 1). The imaging and surgical findings are shown in Table 2. The average size of the cysts was 1.8 cm, and the range was 0.5–5.2 cm. Thirty-one of the 32 patients had rotator cuff tears. The frequency of tendon tears was, in descending order, supraspinatus, infraspinatus, and subscapularis. There were no teres minor tears.

TABLE 1: Patient Demographics

Parameter	Value
Mean age (yr)	57.8
Age range (yr)	26–81
Sex (*n*)	
Male	19
Female	13
Laterality (*n*)	
Right	22
Left	10
MR arthrograms (*n*)	3

Sixteen of 32 cases were associated with partial-thickness rotator cuff tendon tears, 15 of 32 were associated with full-thickness rotator cuff tendon tears, and one was not associated with a visible tear. This last patient had a supraspinatus cyst and tendonopathy of the supraspinatus without a tear on conventional MRI. No surgical correlation was available for this patient.

Of the 11 patients who underwent surgery, all patients with tears on imaging had tears at surgery. The exact location or extent of tears was occasionally difficult to correlate between imaging and surgery because the operative note often referred simply to a full-thickness or partial-thickness rotator cuff tear without specifying which tendons were torn. However, aside from one case of partial-thickness articular surface supraspinatus tear on arthroscopy that was not visible on imaging, all other tears with surgical correlation were correctly classified as of partial thickness or full thickness at MRI. All patients who underwent surgery had successful rotator cuff repair.

The association of intramuscular cysts and rotator cuff tendon tears is shown in Table 3. Of the 14 supraspinatus cysts, 13 were associated with supraspinatus tears, two were associated with tears in two tendons, two were associated with tears in three tendons, and one was associated with no tear.

Of the 11 infraspinatus cysts, all were associated with supraspinatus tendon tears, eight were associated with infraspinatus tendon tears, and four were associated with tears in three tendons. One of the supraspinatus tears was in a patient whose conventional MR images showed an infraspinatus cyst without a visible tear. Arthroscopy showed a partial-thickness articular surface tear of the supraspinatus tendon. This patient also had a posterior superior labral tear seen both on imaging and at arthroscopy and clinical and arthroscopic evidence of posterior superior impingement.

Of five subscapularis cysts, all were associated with supraspinatus tendon tears, four were associated with subscapularis tendon tears, and three were associated with tears in three tendons.

Of the two teres minor cysts, neither was associated with teres minor tears, both were associated with both supraspinatus and infraspinatus tendon tears, and one was associated with tears in three tendons.

In seven patients, a cyst was in a muscle whose tendon was not torn: three infraspinatus, two teres minor, one subscapularis, and one supraspinatus. Six were associated with a tear in the adjacent tendon. Only the patient with the supraspinatus cyst had an intact rotator cuff on imaging.

Discussion

MRI is an accurate examination for rotator cuff tears. In one study, the sensitivity, specificity, and accuracy of MRI for full-thickness rotator cuff tears were 84–96%, 94–98%, and 92–97%, respectively [6]. The accuracy for full-thickness rotator cuff tears at MR arthrography was recently reported as 100% [7]. However, identification of partial-thickness rotator cuff tears has proved more challenging. Although the sensitivity and specificity of MR arthrography for the diagnosis of partial-thickness tears are reported as 84–95% and 96–100%, respectively [7, 8], the sensitivity and specificity of conventional MRI for the diagnosis of partial-thickness rotator cuff tears have been reported as 35–82% and 85–97%, respectively [6, 9]. Therefore, it is important to recognize secondary signs of rotator cuff tears on MRI of the shoulder.

The most commonly described soft-tissue cysts associated with rotator cuff tendon tears are acromioclavicular cysts. These cysts are typically quite large and may present as a supraclavicular mass. These cysts are believed to develop when fluid from a joint or bursa leaks into a degenerated acromioclavicular joint, leading to distention or disruption of the acromioclavicular joint capsule into the supraclavicular soft tissues [3, 4].

The cysts described in this study differ in that they were located within the sheath or

TABLE 2: Imaging and Surgical Findings for 32 Patients with Intramuscular Cysts

Patient No.	Age (yr)	Sex	Laterality	Ganglion Location	Ganglion Size (cm)	Supraspinatus	Infraspinatus	Subscapularis	Teres Minor	Surgery
1	61	Male	Left	IS	1.5	FT	FT	PT/AS	N	FT RCT
2	26[a]	Male	Right	IS	2	PT/AS	PT/AS	N	N	PT/AS RCT
3	80	Female	Right	IS	0.6	FT	FT	N	N	NA
4	75	Male	Right	IS	1.5	FT	N	PT/AS	N	NA
5	79	Female	Right	IS	2	FT	PT/BS	FT	N	FT RCT
6	64	Male	Left	IS	0.8	FT	FT	Tendonopathy	N	FT RCT
7	79	Female	Right	IS	1	FT	FT	PT/AS	N	NA
8	55	Male	Right	IS	0.8	PT/AS	PT/BS	N	N	NA
9	54	Female	Right	IS	8	PT/BS	N	N	N	NA
10	59	Female	Right	IS	2	PT/BS	PT/BS	N	N	NA
11	29	Male	Right	IS	5.2	PT/AS	N	N	N	PT/AS/SS
12	59	Female	Right	SubSC	2	FT	PT/AS	PT/AS	N	FT RCT
13	69	Male	Right	SubSC	1.7	FT	PT BS	PT/AS	N	NA
14	80	Male	Right	SubSC	1	PT/BS	Tendonopathy	PT/AS	N	NA
15	64	Female	Right	SubSC	0.6	FT	PT/AS	PT/AS	N	FT RCT
16	61	Female	Left	SubSC	2.5	PT/BS	N	N	N	NA
17	42	Male	Right	SS	1.5	Tendonopathy	N	N	N	NA
18	59	Female	Right	SS	2	FT	N	N	N	NA
19	67	Male	Left	SS	2.3	FT	N	N	N	NA
20	27	Male	Left	SS	1	PT/AS	Tendonopathy	N	N	NA
21	35	Male	Right	SS	1.4	PT/AS	N	N	N	NA
22	52	Female	Right	SS	2.5	PT/BS	N	N	N	PT/BS/SS
23	38	Female	Left	SS	0.5	PT/BS	N	N	N	NA
24	45	Male	Left	SS	0.7	FT	FT	FT	N	NA
25	81	Male	Right	SS	2	FT	PT/BS	N	N	NA
26	50	Male	Left	SS	1	FT	N	N	N	FT/SS
27	74	Male	Right	SS	1	PT/AS/BS	PT/BS	N	N	NA
28	68	Female	Right	SS	2.3	PT/AS	PT/AS	PT/AS	N	NA
29	35[a]	Male	Left	SS	2.6	PT/AS/BS	N	N	N	PT/AS/BS/SS
30	56[a]	Male	Right	SS	2	PT/BS	N	N	N	NA
31	61	Female	Right	TM	1	FT	PT/Intra	FT	N	FT RCT
32	67	Male	Left	TM	1.6	PT/BS	PT/BS	N	N	NA

Note—IS = infraspinatus, Intra = intrasubstance, FT = full-thickness tendon tear, PT = partial-thickness tendon tear, AS = articular surface, N = normal, RCT = rotator cuff tear, NA = not applicable, BS = bursal surface, SS = supraspinatus, SubSC = subscapularis, TM = teres minor.
[a]MR arthrography.

TABLE 3: Correlation of Cyst Location and Rotator Cuff Tear Location

	Tear Location			
Cyst Location	Supraspinatus	Infraspinatus	Subscapularis	Teres Minor
Supraspinatus (14)	13 (5 FT, 5 PTAS, 3 PTBS)	4 (1 FT, 1 PTAS, 2 PTBS)	2 (1 FT, 1 PTAS)	0
Infraspinatus (11)	11 (6 FT, 3 PTAS, 2 PTBS)	8 (4 FT, 1 PTAS, 3 PTBS)	4 (1 FT, 3 PTAS)	0
Subscapularis (5)	5 (3 FT, 2 PTBS)	3 (2 PTAS, 1 PTBS)	4 (all PTAS)	0
Teres minor (2)	2 (1 FT, 1 PTBS)	2 (1 PTBS, 1 PTIS)	1 (FT)	0

Note—Many cysts were associated with tears in more than one component of rotator cuff. Numbers in parentheses are numbers of patients. FT = full thickness, PTAS = partial-thickness articular surface, PTBS = partial-thickness bursal surface, PTIS = partial-thickness intrasubstance.

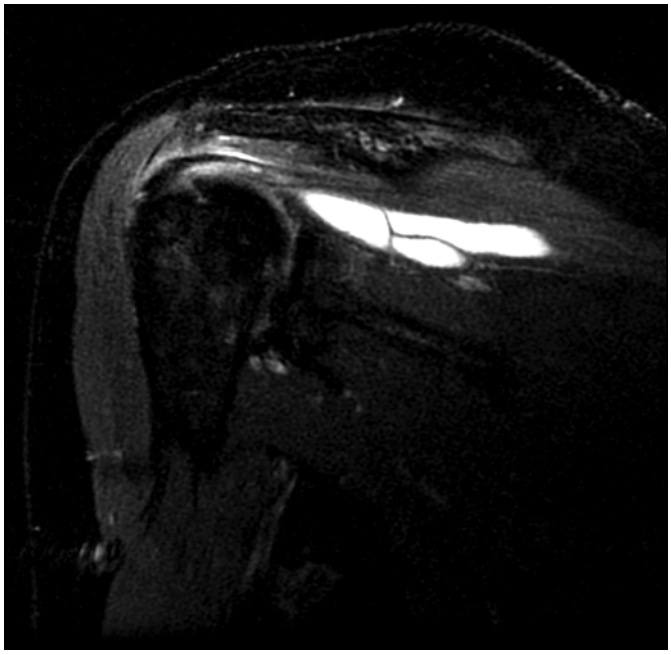

Fig. 1—29-year-old man with shoulder pain. Coronal oblique T2-wighted image shows infraspinatus cyst with intact infraspinatus tendon. Patient had supraspinatus tendon tear (not shown). Partial-thickness articular surface tear of supraspinatus and intact infraspinatus were confirmed at arthroscopy.

substance of the muscles of the rotator cuff and thus were not palpable. Although all but one were associated with rotator cuff tendon tears, approximately half were partial-thickness tears as opposed to the full-thickness tears that have been described with acromioclavicular joint cysts. All the cysts were easily identified on T2-weighted and inversion recovery images as hyperintense fluid collections within the sheath or substance of rotator cuff muscles. Although the size of the cysts varied (range, 0.5–5.2 cm; mean, 1.8 cm), all cysts were oriented along the long axis of the fibers of the involved muscle. None of the cysts was located adjacent to the glenoid labrum, thereby differentiating them from paralabral cysts.

To our knowledge, only two previous publications have specifically described the relationship between intramuscular cysts and rotator cuff tears [5, 10]. In the former study, all 13 cysts were associated with a rotator cuff tear, eight of which were partial-thickness tears. The current study showed similar findings, with 31 of 32 cysts associated with rotator cuff tendon tears, 16 of which were partial-thickness tears. However, unlike the previous study, in which all but one of the cysts were associated with a tear in the tendon of the same muscle, the current study showed seven cases in which the tendon of the muscle containing the cyst was intact. Most of these cases had a tear in the tendon of an adjacent muscle. Although cysts in the supraspinatus, infraspinatus, and subscapularis usually were associated with a tear in the corresponding tendon, teres minor cysts were associated with tears in the tendons of other components of the rotator cuff, including the adjacent infraspinatus. All but one of the cysts were associated with a supraspinatus tendon tear.

The cause of intramuscular cysts is not entirely clear but may be similar to that of paralabral cysts in the shoulder and hip and parameniscal cysts in the knee. As in those other types of cysts, a defect in the surface of a rotator cuff tendon may allow fluid from the glenohumeral joint (or associated bursae) to enter the substance of the rotator cuff tendon and then dissect along the tendon fibers and intramuscular planes to form a cyst either within the sheath or within the substance of a muscle. Such was the case in three patients in whom intraarticular gadolinium was seen entering a tear on the surface of a rotator cuff tendon and dissecting along a horizontal plane into the substance of a rotator cuff muscle. Just as rotator cuff tears may begin in the tendon of one muscle and propagate into an adjacent muscle, the fluid that has entered a rotator cuff tendon may dissect into an adjacent tendon and muscle because tendons interdigitate as they insert into the humerus [11]. This may explain the fact that in seven patients, the tendon of the muscle containing the cyst was intact (Fig. 2). Six of these patients showed a tear in an adjacent tendon, suggesting that the tear may have had a delaminating component that extended into the muscle containing the cyst. The seventh had tendonopathy without a visible tear on conventional MRI.

In one patient, an infraspinatus cyst was identified but no rotator cuff tear was visible on conventional MRI. This patient had a posterior superior labral tear. At surgery, a partial-thickness articular surface tear of the supraspinatus tendon and a posterior superior labral tear were identified and posterosuperior impingement was diagnosed on the basis of clinical and surgical findings. MR arthrography may be beneficial in delineating partial-thickness articular surface tears in patients, such as this one, who have intramuscular cysts on conventional MRI without a visible rotator cuff tear. Occasionally, these undersurface tears are better visualized in the ABER position, possibly because this position removes tension from the undersurface of the cuff (particularly supraspinatus and infraspinatus) and thus facilitates the entry of gadolinium into an articular surface tendon tear [12, 13] (Fig. 3). ABER positioning may also aid in visualization of intrasubstance propagation of the tear through a potential space due to delamination of the layers of the cuff without actual fiber disruption. It is not clear whether ABER positioning in conventional shoulder MRI would also aid in identification of articular surface tendon tears. In either case, if the cyst is related to a bursal surface tear, MR arthrography (and probably

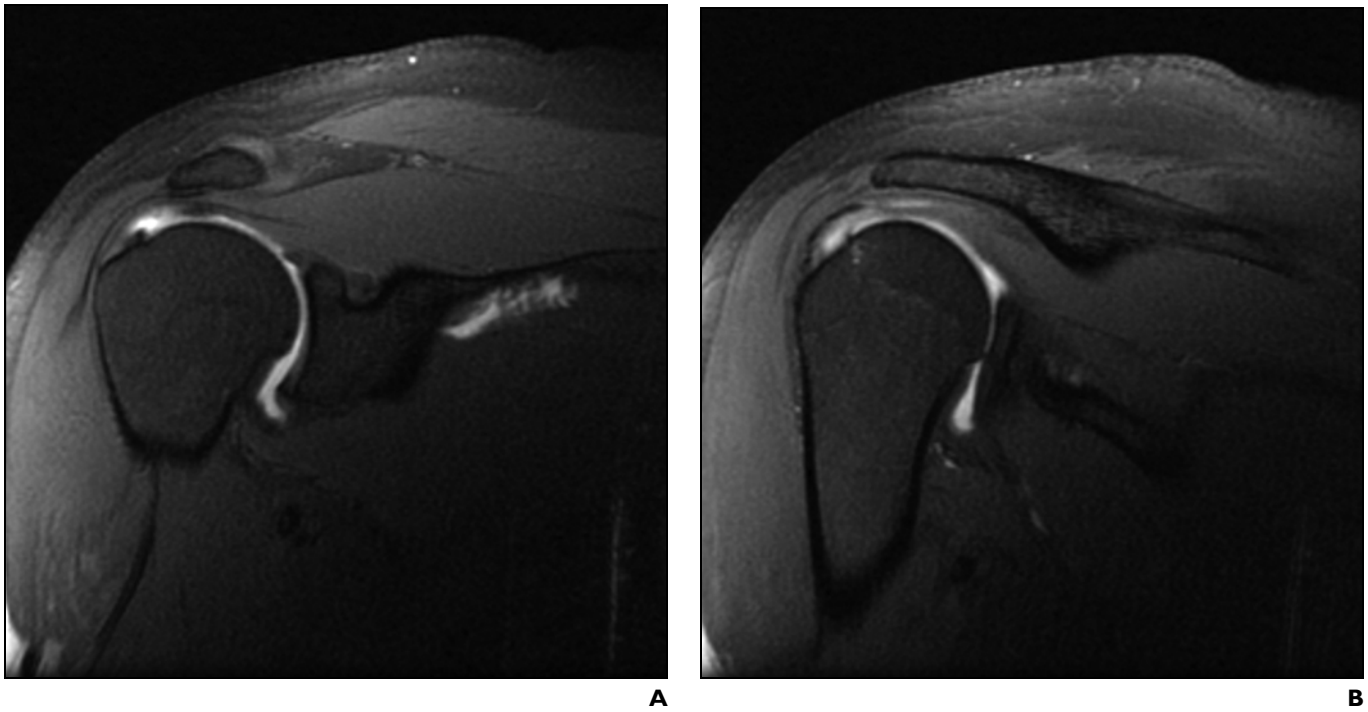

Fig. 2—35-year-old man with shoulder pain.
A, Coronal oblique fat-suppressed T1-weighted image from MR arthrogram shows partial-thickness articular surface tear of supraspinatus tendon.
B, Coronal oblique fat-suppressed T1-weighted image from MR arthrogram posterior to **A** shows delaminating component of tear extending into infraspinatus with intact infraspinatus tendon. Partial-thickness supraspinatus tendon tear and intact infraspinatus were confirmed at arthroscopy.

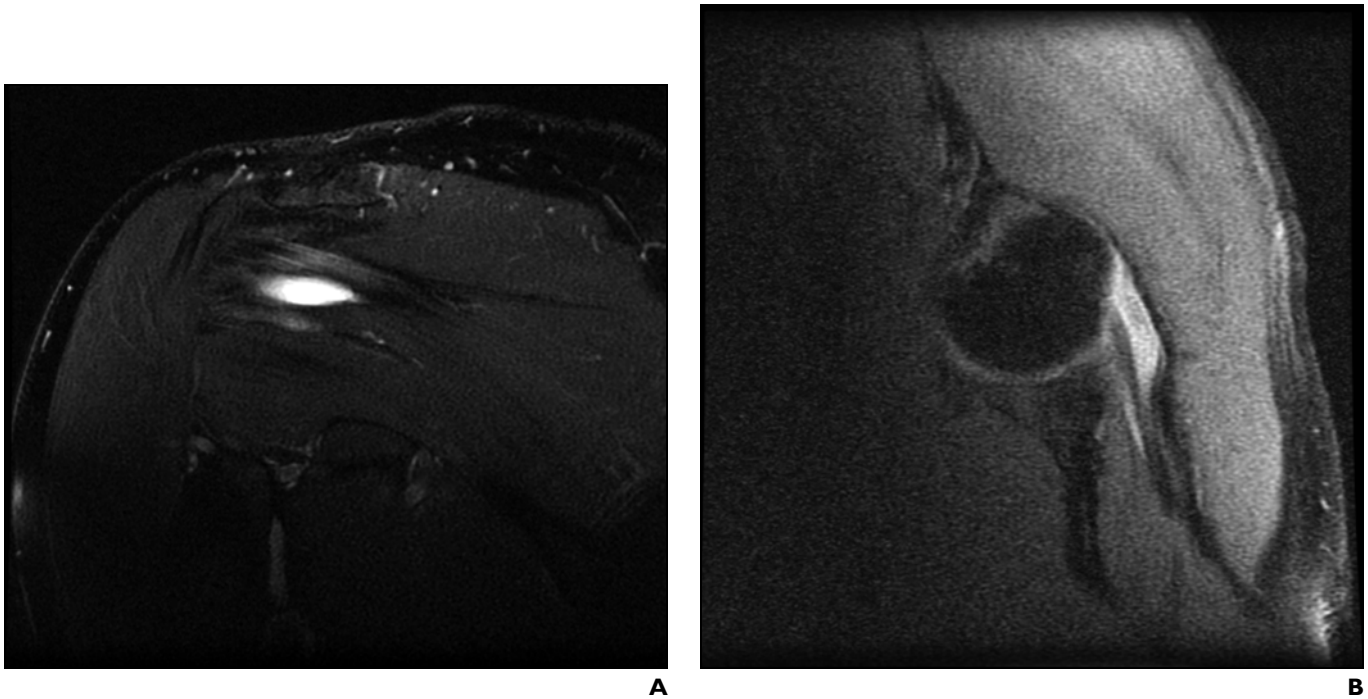

Fig. 3—26-year-old man with shoulder pain.
A, Coronal oblique fat-suppressed T2-weighted image from MR arthrogram shows infraspinatus cyst.
B, Fat-suppressed T1-weighted image from MR arthrogram in abducted and externally rotated position shows partial-thickness articular surface infraspinatus tendon tear and delaminating component of tear. Cyst appears larger than in **A.** Partial-thickness articular surface rotator cuff tendon tear was confirmed at arthroscopy.

ABER imaging) is unlikely to be of additional benefit.

One limitation of this study was that only 11 of 32 patients had surgical correlation. Although surgical correlation led to identification of one additional partial-thickness articular surface rotator cuff tear, given the specificity of MRI for diagnosing rotator cuff tears we are confident in the diagnosis of cuff tears in all patients. If fact, we may have missed some partial-thickness tendon tears on conventional MRI, which has been shown to have only moderate sensitivity to partial-thickness tears. If this were indeed the case, then the association of the intramuscular cysts with rotator cuff tears would be still stronger than suggested by the data presented. Another limitation was that, because this review was retrospective and patients initially were identified by searching for specific keywords in the database of reports, some cases of intramuscular cysts likely were not included either because they were not identified during the initial interpretation or because they were described using words other than "cyst," "ganglion," or "intramuscular." In fact, since the termination of data collection for this study, we have prospectively identified enough of these cysts to believe them more prevalent than suggested by this study. As is the typical distribution of rotator cuff tears, the frequency of cysts was as follows, in descending order: supraspinatus, infraspinatus, subscapularis, and teres minor. The distribution of tears was similar except that none was in the teres minor. The underrepresentation of subscapularis and teres minor cysts and tears may have led to an overestimation of the cyst–tear association in these muscles.

Conclusion

Intramuscular cysts are strongly associated with rotator cuff tendon tears, particularly supraspinatus tears. Half of these cysts are associated with partial-thickness rotator cuff tendon tears, some of which may not be detected on conventional MRI. Identification of an intramuscular cyst should prompt a thorough search of a tendon tear involving not only the muscle containing the cyst but also all the muscles of the rotator cuff, because these cysts may be associated with tears in adjacent muscles. A delaminating component or intrasubstance propagation of a rotator cuff tear that extends from one tendon to another may explain the presence of a cyst in a muscle with an intact tendon.

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